



Georgia Statewide Transportation Plan and Process

*Task 2.3 Integrated Data and
Tools System*

Task 2.4 Sustainable Tools Strategy

final technical memorandum

submitted to

Georgia Department of Transportation

submitted by

Cambridge Systematics, Inc.

July 2000

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System of Tools

■ 1.0 Introduction

This memorandum covers workplan Subtask 2.3 – “development of an integrated data and tools system to support this project” – and Subtask 2.4 – “develop a sustainable tools strategy.” It builds upon the Subtask 2.2 technical memorandum – “an inventory of existing information systems resources” – by incorporating edits received by GDOT reviewers and additional information obtained by contacted GDOT staff to fill in the blanks from the earlier memoranda. The attached Table 1 provides an inventory of the performance measures that may be used in this plan update, the tools and data that support each performance measure, and the method by which the tools and data will be employed in this and future plan updates.

Since this memorandum is based on information that was reviewed by the GDOT staff and managers with whom we met on March 9-10, it also serves as the meeting minutes for the discussions conducted during these meetings. This memorandum completes an information systems plan to support the issues, analyses, and policies at the core of the Statewide Transportation Plan itself.

■ 2.0 Background

Cambridge Systematics (CS) team members visited the Department on March 9 and 10, 2000 to review a proposed list of performance measures and the tools and data that would support those performance measures. The performance measures for the plan update are not scheduled to be finalized until Task 7. A tentative list of performance measures was identified for purposes of preparing the system of tools based on the illustrative list of performance measures identified in the Task 7 of the Scope of Work, Cambridge Systematics team experience, and discussions with GDOT staff. The tools and data identified were, for the most part, those inventoried in the Task 2.2 Technical Memorandum. The tools identified in Task 2.2, while largely complete, could not provide all of the necessary information to support the performance measures. Two necessary components of any system of evaluation measures – the amount of travel on the highway system in rural areas and the average highway operating speeds – are not available through the current tools maintained by GDOT. Tools that are not currently in use at GDOT but which are available and could be used to provide the necessary information are discussed in the following sections.

2.1 Vehicle Miles of Travel

Critical to a number of the performance measures are forecasts of Vehicle Miles of Travel (VMT) on the highway system for the urban and rural areas of Georgia. While VMT forecasts that are sensitive to changes in economic conditions are available for the urban areas covered by the Metropolitan Planning Organizations (MPOs), no comparable tool exists for rural areas. Forecasts of rural VMT for the 1995 Statewide Transportation Plan, as

prepared using the Highway Performance Monitoring System Analytical Process (HPMS AP), were based on historical trends in observed traffic volumes and were not sensitive to changes to changes in future economic conditions.

Outside of the urbanized areas, GDOT does not have the capability to produce highway forecasts that are sensitive to changes in economic conditions. Forecasts of highway volumes are done primarily through a trend analysis of historical traffic volumes. This produces travel forecasts that are sufficient for project planning, but it does not allow for the policy testing that is to be a part of the SWTP. At this time Georgia DOT is still considering the creation of a sophisticated statewide travel demand forecasting model that would be sensitive to economic policy variables. Such a model will not be available for this update of the SWTP, but if and when one is developed, it should be used in future updates.

As documented in the Task 2.2 Technical Memorandum, Appendix A, a simple equation was developed for statewide VMT based on population and employment. The coefficients of the equation were developed through linear regression of historical data over the period 1990-1997. The resulting equation fit the observed data very well ($R^2 = 0.981$) and took the form of:

$$VMT = 0.021P + 0.0018E - 73,500$$

where:

VMT = annual VMT in millions,

P = state population, and

E = state employment.

This equation states the annual VMT as the sum of the population multiplied by the constant 0.021, and the employment multiplied by the constant 0.00018, adjusted by subtracting a constant adjustment term, 73,500. This indicates that VMT is expected to increase as both population and employment increase, although at different rates. This equation can be considered to be an addition to the inventory of tools identified in the previous memoranda.

2.2 Highway Economic Requirements System (HERS)

The ability to identify congested travel speeds on highways is critical to a number of performance measures. Those speeds may be used as a performance measure themselves, be used to calculate the total Vehicle Hours of Travel (VHT) on the highway system, or be used to calculate the air emissions. The MPO Travel Demand Models have been calibrated to replicate observed volumes but, with the exception of the Atlanta area, the congested speeds calculated by the model have not been calibrated to observed speeds. For rural areas, the Multimodal Transportation Planning Tool calculates congested speed on individual roadways based on that roadway's Average Daily Traffic, but is not structured to produce average travel speed on a systemwide basis. While both the MPO models and MTPT could be modified to produce congested travel speeds, they would not be available to produce this basic travel measure as part of this plan update.

The Federal Highway Administration (FHWA) has developed the Highway Economic Requirements System Model (HERS) to estimate future investment requirements of the Nation's highway system for the U.S. Congress. One of the components of HERS is the calculation of travel speed on highway links based on the roadway characteristics and traffic volumes included in the Highway Performance Monitoring System (HPMS) files. HERS uses these travel speeds to estimate the costs associated with air emissions, fuel consumption, congestion, etc. Using GDOT's HPMS file and the traffic growth rates produced by the VMT forecasting equation described in Section 2.1, it will be possible for HERS to produce the congested speeds, and by extension VHT and other related measures, that will be used in calculating many performance measures.

HERS also produces estimates of accidents and accident rates that will vary in response to traffic forecasts. It provides a method to assess the changes in safety of the highway system, in response to changing economic and associated travel forecasts. It provides an alternative to applying the existing system rates to future conditions, without consideration of how those accident rates might change in response to increasing volumes. Based on the HERS national experience for example, injury rates increase but fatality rates decrease with increasing volumes. Thus congestion gives rises to more frequent but less severe accidents. For this plan update, it is recommended that HERS be used by scaling the HERS accident forecasts based the relationship of Georgia to national system rates. For future plan updates, it is recommended that Georgia specific rates by volume range and facility type be developed in the HERS format.

■ 3.0 System of Tools

The proposed system of tools is presented in Table 1. The purpose of the system of tools is to support the evaluation of this and future transportation plan updates. The table is organized by the same functional areas (asset management, travel demand forecasting, air quality, and intermodal) that were the basis of the Subtask 2.1 and 2.2 memoranda. An additional area, Basic Performance Measure, is listed first to cover two items, VMT and VHT, which, while not performance measures in themselves, are necessary components of many other performance measures.

The performance measures are listed as the rows on Table 1. The columns list, for each performance measure, the following:

- The performance measure;
- The tool or tools available to GDOT, as described in the Subtask 2.2 or this memorandum, that support the calculation of the performance measure;
- The forecast variables that are required to calculate the performance measure;
- The method to be employed in calculating the performance measure in this update of the Statewide Transportation Plan; and
- The method to be employed in calculating the performance measure as part of a sustainable system of tools supporting future plan updates.

While not listed as a performance measure, the use of geographic information systems (GIS) is an integral part of managing and displaying the information that is part of the system of tools. Many of the performance measures require the use of data and calculations from multiple information systems (for example, the intermodal performance measures of pavement condition on NHS Intermodal Connectors). The linking of separate spatial information systems is a key attribute of GIS.

The performance measures themselves also have a spatial component that is readily displayed in maps of the transportation system. The ability to view pavement conditions on a map of Georgia roadways, or a map of the counties served by rural transit, conveys the information in the evaluation measures far better than a simple tabular listing. For its ability to manage, relate, and display information, it is essential that GIS be employed as part of the system of tools.

The Office of Information Services manages GDOT's GIS data and systems. Their resources are excellent, mostly used for mapping. Almost any type of roadway data can be mapped. GDOT maintains a mapping Web site, traffic counts and bridge load information are available by location statewide. The linking of other databases is a goal of the Transportation Information System (TIS) that is being developed by GDOT. When fully implemented, TIS will link the important transportation databases to GIS. All GDOT geographic data is prepared by GDOT's Office of Information Systems (OIS) and submitted to the Georgia GIS Data Clearinghouse for access by the public and public agencies

As part of this plan update, the CS team will use the Arc/Info and ArcView GIS platforms and the Oracle databases supported by the Department. The CS team will rely on the County Roads, Railroads, Hydrography, Airports, Utilities and Highways layers and the State DOT, City, County, RPC, and, Digital Orthophotography Quarter Quadrangles (DOQQs) layers developed by the OIS. All databases developed as part of this plan update will be linked to the GIS system.

As part of future plan updates, it is recommended that GDOT make full use of the integration of databases made possible by the full implementation of the TIS. This will enhance the utilization, exchange, and display of the data in a more efficient and effective manner.

Table 1. Systems of Tools by Performance Measure

Performance Measure <i>(necessary for other performance measures)</i>	Tool(s)	Forecast Variables	Method - This SWTP Update	Method - Future SWTP Updates
Basic Performance – Vehicle Miles of Travel – Statewide	VMT Forecasting Equation and MPO Travel Demand Models	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Use the proposed regression equation for VMT as a function of population and employment to establish a statewide value for each economic forecast. Scale the MPO Travel Demand Model forecast of VMT based on the relationship of the MPO population and employment forecasts to the economic forecasts. Sum the VMT for all urban areas. Subtract the total urban area VMT from the statewide total. The result is the forecast rural VMT.	Calculate the statewide VMT through the regression equation. Run the urban area models with the population and employment forecasts from an economic analysis. Sum the VMT for all urban areas. Subtract the total urban area VMT from the statewide total. The result is the forecast rural VMT.
Basic Performance – Vehicle Hours of Travel – Statewide	Highway Economic Requirements System (HERS) this update; MPO Travel Models, Enhanced MTPT future updates	Vehicle Miles of Travel, population and employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low), HPMs files	Use the link speed estimation feature of HERs to calculate Vehicle Hours of Travel in response to changes in the growth rate of traffic from the VMT forecast.	Run the urban area models with the population and employment forecasts from the economic analysis. Enhance MTPT to produce system-level rural VHT based of link speeds. Sum the VHT for all urban areas and the rural VHT.

Table 1. Systems and Data Resources Overview (continued)

Performance Measure	Tool(s)	Forecast Variables	Method - This SWTP Update	Method - Future SWTP Updates
<i>Asset Management</i>				
Pavement Condition	PACES (Pavement Condition Evaluation System)	Vehicle Miles of Travel, PACES file	Project needs based on prediction models developed by the GDOT Office of Materials and Research using the computerized PACES file (CoPACES, in Microsoft Access) using Average Daily Traffic growth rates consistent with the project growth in VMT.	Project needs based on prediction models developed by the GDOT Office of Materials and Research using the computerized PACES file (CoPACES, in Microsoft Access) using Average Daily Traffic growth rates consistent with the project growth in VMT.
Bridge Condition	Pontis	Vehicle Miles of Travel, BIMS database	Use PONTIS to generate needs using Average Daily Traffic growth rates consistent with the projected growth in VMT.	Use PONTIS to generate needs using Average Daily Traffic growth rates consistent with the projected growth in VMT.
Safety:	Highway Economic Requirements System (HERS)	Vehicle Miles of Travel, Georgia Accident Rates	Use HERs to estimate future systemwide Crash Rates based on projected growth in VMT, and national accident rates. Scale to Georgia conditions based on relationship to national accident rates	Use HERs to estimate future systemwide Crash Rates based on projected growth in VMT. Develop Georgia-specific accident rates for typical link sections as a function of AADT from the Georgia Department of Public Safety's Accident database
<i>Travel Demand Forecasts</i>				
Vehicle Miles of Travel per capita	VMT Forecasting Equation and MPO Travel Demand Models	Vehicle Miles of Travel, Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Divide the VMT totals produced by the regression equation and the scaled MPO forecasts by the populations to calculate VMT per capita.	Divide the VMT totals produced by the regression equation and the scaled MPO forecasts by the populations to calculate VMT per capita.

Table 1. Systems and Data Resources Overview (continued)

Performance Measure	Tool(s)	Forecast Variables	Method - This SWTP Update	Method - Future SWTP Updates
<i>Travel Demand Forecasts (continued)</i>				
Vehicle Hours of Travel per capita	Highway Economic Requirements System (HERS) this update; MPO Travel Models, Enhanced MTPT future updates	VHT, Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Divide the VHT from HERS by population to produce VHT per capita.	Divide the VHT produced by the MPO models and an Enhanced MTPT by population to produce VHT per capita.
Commuter rail ridership	Commuter Rail Model	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Coordinate with GDOT's consultant by providing population and economic forecasts to be used in the Commuter Rail Passenger Program study currently underway. Use the ridership forecasts prepared for the GRPP	Run the Commuter Rail Model with updated SWTP economic forecasts.
Intercity bus, rail, and air ridership	Intercity Rail Model	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Coordinate with GDOT's consultant by providing population and economic forecasts to be used in the Commuter Rail Passenger Program study currently underway. Use the ridership forecasts prepared for the GRPP	Run the Intercity Rail Model with updated SWTP economic forecasts
Urban Transit ridership per capita	Enhanced Urban Area Models, MTPT	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Not used as part of this update for urban areas. Transit ridership forecasts for urban areas are not available, with the exception of Atlanta. Rural transit ridership is produced by MTPT	Enhance the Urban Area Models to produce transit riders, either through a simplified percentage or a mode split process. Rural transit ridership is produced by MTPT

Table 1. Systems and Data Resources Overview (continued)

Performance Measure <i>Travel Demand Forecasts (continued)</i>	Tool(s)	Forecast Variables	Method - This SWTP Update	Method - Future SWTP Updates
Trips per Capita	MPO Travel Demand Models, GDOT Trip Generation Equations	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Use the reported VMT and trips from the MPO Travel Demand Models. For rural areas apply the GDOT Trip Generation Equations to rural population and employment. Using the VMT calculations, calculate the average trip length as the ratio of the VMT divided by the number of trips	Run the MPO Travel Demand Models and use the resulting VMT and trips. For rural areas apply the GDOT Trip Generation Equations to rural population and employment. Using the VMT calculations, calculate the average trip length as the ratio of the VMT divided by the number of trips
Rural Transit ridership per capita	MTPT	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Rural transit ridership is produced by MTPT.	Rural transit ridership is produced by MTPT
Average speed	Highway Economic Requirements System (HERS) this update; MPO Travel Models, Enhanced MTPT future updates	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Use the link speed estimation feature of HERS to calculate Vehicle Hours of Travel in response to changes in the growth rate of traffic from the VMT forecast. Divide the VMT by VHT to calculate average system speed.	Run the urban area model's with the population and employment forecasts from the economic analysis. The MTPT, as currently designed, provides, among other information, LOS based on travel speeds for specific facilities as requested by the user. For all facilities not included in the urban area models, enhance MTPT to produce system-level average speed based on information in GDOT's Road Characteristic file.

Table 1. Systems and Data Resources Overview (continued)

Performance Measure	Tool(s)	Forecast Variables	Method - This SWTP Update	Method - Future SWTP Updates
<i>Travel Demand Forecasts (continued)</i>				
Recurring delay	Highway Economic Requirements System (HERS) for this update; MPO Travel Models, Enhanced MTPT future updates	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Use the link speed estimation feature of HERS to calculate Vehicle Hours of Travel in response to changes in the growth rate of traffic from the VMT forecast. Use HERS to calculate the VHT at free flow speeds. Calculate the delay as the difference between the free-flow and congested VHT time as reported by the model.	Run the urban area models with the population and employment forecasts from the economic analysis. Calculate the delay as the difference between the free-flow and congested travel time as reported by the model. Sum the urban area delays to calculate the urban total delay. Use an Enhanced MTPT to calculate rural system delay as the difference between the free-flow and congested travel time on each link.
Average Trip Length	VMT Forecasting Equation and MPO Travel Demand Models	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low). VMT forecasts	Calculate the total trips for each using the population and employment forecast and the GDOT trip generation equations. Using the VMT calculations, calculate the average trip length as the ratio of the VMT divided by the number of trips. Do this separately for each urban area and for the rural areas	Run the Urban Travel Demand Models and use the resulting VMT and trips. For rural areas apply the GDOT Trip Generation Equations to rural population and employment. Using the VMT calculations, calculate the average trip length as the ratio of the VMT divided by the number of trips

Table 1. Systems and Data Resources Overview (continued)

Performance Measure	Tool(s)	Forecast Variables	Method - This SWTP Update		Method - Future SWTP Updates	
			CS Team Leader: Jack Henneman (Day Wilburn)			
Air pollution emissions	Highway Economic Requirements System (HERS) this update; Urban Travel Demand Models, GDOT emissions procedure.	Vehicle Emission Rates, population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low).	Use HERS with the Georgia-specific emission rates to calculate air emissions.	Run the urban area emission models with the population and employment forecasts from the economic analysis. Report the emissions by pollutant.	Run the urban area emission models with the population and employment forecasts from the economic analysis. Report the emissions by pollutant. For non-regional pollutants (CO and PM-10) calculate the emissions exposure to minority and low-income populations through a GIS analysis based on the summation of emissions on links located in minority and low-income areas.	Run the urban area emission models with the population and employment forecasts from the economic analysis. Report the emissions by pollutant. For non-regional pollutants (CO and PM-10) calculate the emissions exposure to minority and low-income populations through a GIS analysis based on the summation of emissions on links located in minority and low-income areas.
Air pollution emissions – by minority and low-income population area	Highway Economic Requirements System (HERS) this update; Urban Travel Demand Models, GDOT emissions procedure, GIS.	Population and Employment (Statewide and/or MPO) for three economic forecasts (high, medium, and low). GIS layers of minority and low-income population.	Use HERS with the Georgia-specific emission rates to calculate air emissions. For non-regional pollutants (CO and PM-10) calculate the emissions exposure to minority and low-income populations through a GIS analysis based on the summation of emissions on links located in minority and low-income areas.	Run the urban area emission models with the population and employment forecasts from the economic analysis. Report the emissions by pollutant. For non-regional pollutants (CO and PM-10) calculate the emissions exposure to minority and low-income populations through a GIS analysis based on the summation of emissions on links located in minority and low-income areas.	Run the urban area emission models with the population and employment forecasts from the economic analysis. Report the emissions by pollutant. For non-regional pollutants (CO and PM-10) calculate the emissions exposure to minority and low-income populations through a GIS analysis based on the summation of emissions on links located in minority and low-income areas.	Run the urban area emission models with the population and employment forecasts from the economic analysis. Report the emissions by pollutant. For non-regional pollutants (CO and PM-10) calculate the emissions exposure to minority and low-income populations through a GIS analysis based on the summation of emissions on links located in minority and low-income areas.

Table 1. Systems and Data Resources Overview (continued)

Performance Measure	Tool(s)	Forecast Variables	Method - This SWTP Update	Method - Future SWTP Updates
Intermodal Systems CS Team Leader: Alan Meyers				
Truck Load Equivalents of freight	Forecasts of freight tonnage by operators	Population and Employment for three economic forecasts (high, medium, and low).	Scale the forecasts of freight based on the relationship of the economic conditions on which they are based to the economic variables prepared for the SWTP update.	Scale the forecasts of freight based on the relationship of the economic conditions on which they are based to the economic variables prepared for the SWTP update.
Intermodal Accessibility	Pontis, PACES, Safety Management System, HERS (this Update), MPO Travel Demand Models, Enhanced MTPT (future updates)	HPMS file, Vehicle Miles of Travel, PACES file, BIMS database.	Use PAGES, Pontis, and the Safety Management System and HERS to identify the pavement condition, bridge condition, accident rates and congestion on the designated NHS Intermodal Connectors.	Use PAGES, Pontis, and the Safety Management System and HERS to identify the pavement condition, bridge condition, accident rates and congestion on the designated NHS Intermodal Connectors.